TENNELEC

INSTRUCTION MANUAL
TC 590
PRECISION RATEMETER

MP MASTER
MA30995

Warranty

TENNELEC, Inc. warrants that the products or components manufactured by it shall be free from defects in material or workmanship for a period of one year from the date of delivery to purchaser. If such product or component is determined to be defective by TENNELEC, its sole warranty obligation shall be limited to either replacing or repairing such defective product or component or allowing credit therefor, at TENNELEC's option. Such warranty is further conditioned upon the purchaser's giving prompt notice of any such defect and satisfactory proof thereof to TENNELEC's customer service manager; thereafter upon TENNELEC's approval, the purchaser shall return such defective product or component to TENNELEC's factory at Oak Ridge, Tennessee, all transportation charges prepaid. TENNELEC shall be responsible only for transportation charges incurred in returning such product or component to purchaser. All customs, brokerage and duty charges shall be at the expense of the purchaser. Damage in transit due to inadequate packaging will be repaired at purchaser's expense. Any repairs or replacements by the purchaser without TENNELEC's approval, any willful abuse or any evidence that the product or component was not properly used and maintained, would automatically void this warranty.

TENNELEC makes no warranty whatsoever in respect to products or components not manufactured by it but instead the applicable warranties, if any, of the respective manufacturers thereof shall apply. Likewise fuses, batteries and input transistors in ultra low-noise amplifiers are specifically excluded from this warranty.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, STATUTORY OR OTHERWISE, INCLUDING WARRANTY OF MERCHANTABILITY AND FITNESS.

TENNELEC

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MODEL

SERIAL NO.

INSTRUCTION MANUAL

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MODEL TC 590 PRECISION RATEMETER

1.0 INTRODUCTION

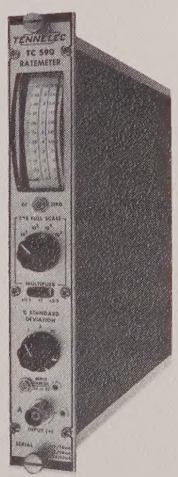
For modern counting systems that require a precision ratemeter, the Model TC 590 provides a comprehensive choice of count-rate ranges (50 to 250,000 counts per sec in a 5-10-25 sequence). It can accept virtually any positive pulse since it contains an integral discriminator that covers a 0.15 to 10V range and responds to signals as short as 10 nsec. Readout is by edgewise meter.

A 'Percent Standard Deviation' switch permits operation at a known statistical meter fluctuation with minimum response time. Changing the position of the switch does not change the instantaneous meter reading that would result in a 'quick change' feature at low count rates where the response time would otherwise be quite long.

2.0 SPECIFICATIONS

RANGES	10^2, 10^3, 10^4, and 10^5 cps full-scale, multiplied by switch-selectable factors of 0.5, 1, and 2.5 providing ranges of 50, 100, 250, 500, 1000, 2500, 5000, 10,000, 25,000, 50,000, 100,000, and 250,000 counts per second full-scale.
ACCURACY	
METER	3% of full scale.
RECORDER OUTPUT	1% of full scale.
NONLINEARITY	0.1% of full scale plus meter nonlinearity.
TEMPERATURE STABILITY	0.008% per °C.
OPERATING TEMPERATURE	0° to 50°C.
TIME CONSTANT	Calibrated in Percent Standard Deviation. Switch-selectable: 1, 3, and 10% at full scale.
PULSE PAIR RESOLUTION	375 nsec.
INPUT PULSE REQUIREMENTS	
POLARITY	Positive.
AMPLITUDE	0.15 to 10V; dependent on threshold setting.
SHAPE	Unipolar or bipolar (positive lobe leading).
MINIMUM WIDTH	10 nsec fwhm, input pulse 50% over the threshold; 20 nsec, input pulse at the threshold.
MAXIMUM WIDTH	No limitation.
INPUT TERMINAL CHARACTERISTICS	
COUPLING	DC.
IMPEDANCE	1 kΩ.
RECORDER OUTPUT	Adjustable: 0 to 100mV.
READOUT	Edgewise meter.
FRONT PANEL CONTROLS	
DC ZERO	One 25-turn screwdriver-adjustable potentiometer.

MULTIPLIER	Three-position slide switch.
% STANDARD DEVIATION	Three-position rotary switch.
COUNTS FULL SCALE	Four-position rotary switch.
INPUT THRESHOLD	One 25-turn screwdriver-adjustable potentiometer.
REAR PANEL CONTROL	
RECORDER OUTPUT ADJUST	One 25-turn screwdriver-adjustable potentiometer.
CONNECTORS	
SIGNAL INPUT	BNC (UG-1094/U) on front panel.
RECORDER OUTPUT	Binding posts on rear panel.
POWER	NIM standard connector on rear panel.
ACCESSORIES	One instruction manual.
POWER REQUIREMENTS	+12V at 70 mA. −12V at 20 mA. +24V at 10 mA.
PACKAGING	No. 1 AEC NIM Standard Width.
NET WEIGHT	2 lbs 10 oz (1.5 kg).
SHIPPING WEIGHT	4 lbs 10 oz (2.4 kg).
WARRANTY	[redacted] one year



3.0 CONTROLS AND CONNECTORS

3.1 CPS FULL SCALE

This four-position rotary switch provides 10^2, 10^3, 10^4, and 10^5 cps full-scale that can be multiplied by switch-selectable factors (MULTIPLIER) of 0.5, 1.0, and 2.5 to provide counting ranges of 50, 100, 250, 500, 1000, 2500, 5000, 10,000, 25,000, 50,000, 100,000, and 250,000 cps full scale.

3.2 MULTIPLIER

This three-position slide switch provides 0.5, 1.0, or 2.5 times multiplication of the value of each position of the CPS FULL SCALE. In the 0.5 position, count rates of 50, 500, 5000, and 50,000 cps are available; at 1.0, 100, 1000, 10,000 and 100,000; and at 2.5, 250, 2500, 25,000, and 250,000. Three separate scales on the edgewise meter facilitate easy reading.

3.3. % STANDARD DEVIATION

This three-position rotary switch allows the user to select accuracies of 1, 3, or 10% standard deviation with the fastest possible time response.

3.4 INPUT THRESHOLD

This 25-turn screwdriver-adjustable potentiometer provides for selection of a chosen threshold (0.15 to 10V) to ensure that signals of amplitudes less than the threshold setting will not be counted. The threshold voltage may be measured with a DC voltmeter at the pin jack located to the right of this control.

3.5 SIGNAL INPUT CONNECTOR

This BNC connector accepts positive unipolar or bipolar (positive lobe leading) pulses of 0.15 to 10V amplitude. The minimum width of acceptable pulses is 10 nsec fwhm when the input pulse is 50% over the threshold and 20 nsec when the input pulse is at the threshold.

3.6 RECORDER OUTPUT

This 25-turn screwdriver-adjustable potentiometer located on the rear panel provides for adjustment of the recorder output voltage over a 0 to 100 mV range. The potentiometer is factory set to provide a nominal 100 mV output voltage; instructions for changing the factory setting are given in Section 4.2 of this manual.

3.7 DC ZERO ADJUSTMENT

This 25-turn screwdriver-adjustable potentiomenter sets the electronic dc zero of the TC 590. Instructions for adjustment of the dc zero level are given in Section 6.1.

4.0 OPERATION PROCEDURES

4.1 FIRST-TIME OPERATION

Every instrument from TENNELEC, Inc. is thoroughly checked before it leaves the plant. However, it is possible for damage to occur during shipping and it is advised that a few tests be run before the instrument is put into actual operation.

Visually check the Model TC 590 upon receipt for possible external damage. If it appears to be damaged, proceed according to the instructions given in the SHIPPING DAMAGE section of this manual.

Insert the instrument into a bin that accepts standard nuclear instrumentation modules. It is recommended that the power supply of the bin be OFF when the module is inserted.

The only test instrument recommended for initial operation of the TC 590 Ratemeter is a powered pulse generator that has a variable repetition rate (Tetronix 114 or equivalent). Connect the TC 590 to the pulse generator and feed a 2 V, 2 μsec signal into the TC 590 at the rate of 1kHz/sec. Vary the repetition rate of the pulse generator and observe the edgewise meter. Note the effect of changing the % STD. DEVIATION switch; the time constant is much longer in the 1% position than in the 10% position.

CAUTION: The TC 590 was calibrated with a highly accurate and stable pulse source. Section 6.2 must be read before any adjustments are attempted if the TC 590 appears to be out of calibration.

4.2 GENERAL OPERATION

4.2.1 The threshold discriminator in the TC 590 can be adjusted to trigger on pulses that range in amplitude from 0.15 to 10V by means of the INPUT THRESHOLD control; the threshold voltage is measured at the pin jack located to the right of the INPUT THRESHOLD control. An electronic voltmeter or a 20 kΩ volt-ohm-milliammeter (VOM) should be used. The voltage measured at the pin jack is one-half (±10%) of the true threshold setting. For example, if 2.5V is measured at the pin jack, the threshold is set to trigger on 5V pulses.

CAUTION: As with any low hysteresis discriminator, excessive noise and/or ringing on the input pulse can cause multiple triggering in the TC 590; this can result in an indicated count rate that is higher than the actual count rate. Care should be taken to ensure that quality pulses enter the ratemeter. If the user has no control over the input pulse shape, the threshold of the ratemeter should be set at a level low enough so that each input is well above it but not so low that the ratemeter responds to noise in the signal source.

4.2.2 Radioactive events have a random time distribution, and because of this characteristic, the ratemeter indication will fluctuate from instant to instant. To control the magnitude of this fluctuation, a % STANDARD DEVIATION control is furnished. This control connects one of three possible capacitors across the ratemeter scale resistor and provides smoothing action. The residual fluctuations have a Gaussian distribution with respect to time if equilibrium has been established,

and the 1%, 3%, and 10% designations on the % STANDARD DEVIATION control refer to the relative standard deviation of this distribution (or equivalently, the root mean square or rms value of the fluctuation) at full scale. For example, if the scale factors are set for 1000 cps and 10% standard deviation, the rms fluctuation will be ±100 cps or 10% of the meter reading. It should be noted, however, that for any other meter reading, the relative standard deviation normalized to the absolute meter reading is inversely proportional to the square root of the fraction of full scale meter needle position. For example, at one-fourth (¼) full scale, the absolute rms fluctuation for scale factors set at 1000 cps and 10% standard deviation would be 50 cps which corresponds to 20% of the full scale reading.

With regard to equilibrium being established, it should be noted that when a steady count rate is suddenly applied to the ratemeter, the meter reading does not suddenly jump to its final value but approaches it exponentially with the time constant of the smoothing circuit. Thus, to be within *n*% of the equilibrium reading, *m* time constants must be allowed from the instant a steady count rate is applied, where *n* and *m* are given in Table 1.

n%	50	37	10	5	3	1
m time constants	0.7	1	2.3	3.0	3.5	4.6

Table 1.

The time constant, in seconds or milliseconds as a function of the scale and standard deviation control settings are given in Table 2. It will be noted that at full scale settings of 100 cps and 1% standard deviation, the time constant is 100 seconds.

FULL SCALE RANGE		% STANDARD DEVIATION		
		1% (1μF)	3% (0.1μF)	10% (0.01μF)
	Resistor			
50	100MΩ	100 sec	10 sec	1.0 sec
100	50MΩ	50 sec	5 sec	0.5 sec
250	20MΩ	20 sec	2 sec	0.2 sec
500	10MΩ	10 sec	1 sec	0.1 sec
1000	5MΩ	5 sec	0.5 sec	0.05 sec
2500	2MΩ	2 sec	0.2 sec	0.02 sec
5000	1MΩ	1 sec	0.1 sec	0.01 sec
10,000	500MΩ	00.5 sec	50 msec	5 msec
25,000	200kΩ	0.2 sec	20 msec	2 msec
50,000	100kΩ	0.1 sec	10 msec	1 msec
100,000	50kΩ	0.05 sec	5 msec	0.5 msec
250,000	20kΩ	0.02 sec	2 msec	0.2 msec

Table 2.

When the % STANDARD DEVIATION control is set at 1%, the response time is very slow and 100 sec may be required for the meter to reach equilibrium at the true count rate. For this reason, a unique quick charge feature, which charges the integrating capacitor to affect a drastic reduction in response time, was included in the TC 590. If readings are to be made at the 1% position, it is recommended that the % STANDARD DEVIATION control be set at 3% and the meter allowed to stabilize. The % STANDARD DEVIATION control can then be changed to the 1% position without fluctuation in the readout of the meter.

When the pulse source is removed or the TC 590 is subjected to overload, the CPS FULL SCALE control should be set to a higher range to effect a rapid return of the needle to zero.

4.2.3 Recorder Output

The recorder output voltage can be set between 0 and 100 mV by means of the RECORDER OUTPUT control. The nonlinearity of this output is the inherent nonlinearity of the circuit: less than 0.1%.

The resistor, R34, should be changed if a different range of full-scale output voltage is required. The only precaution to be observed in this modification is that the current from the amplifier output through R34 should be no more than 1 mA.

5.0 APPLICATIONS

The Model TC 590 Ratemeter determines the rate (events/unit time) with which certain nuclear events occur; it electronically performs the counts/unit time calculation.

Using different building-block modules, the events counted can be restricted by energy range or by time coincidence, or they can be simply a gross count of activity rate. Figure 1 illustrates a typical nuclear spectroscopy system in which the TC 590 is used to obtain a gross count of activity rate.

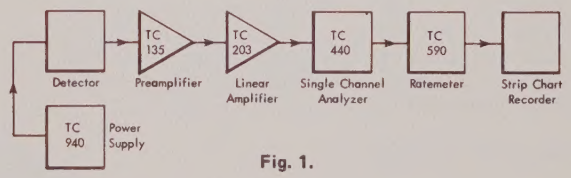


Fig. 1.

Figure 2 shows a typical nuclear counting system in which the TC 590 is used to obtain a gross count of activity at a certain energy range.

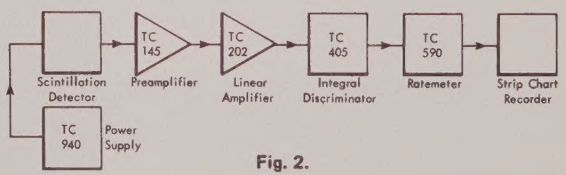


Fig. 2.

Other than being used in engineering and research applications, the Model TC 590 can also be used in radiation survey and radiation monitoring systems.

6.0 ADJUSTMENTS

6.1 DC ZERO

Before any type of calibration is attempted on the TC 590, the DC ZERO must be checked. With the power OFF, the needle of the edgewise meter should rest directly over the zero line on the scale. If it does not, remove the left side shield and locate the screwdriver adjustable control on the rear of the METER. This control provides for mechanical adjustment of the edgewise meter to a reading of zero.

When the pointer reads zero with the power OFF, set the CPS FULL SCALE control at 10^2, the MULTIPLIER control at 0.5 and the % STANDARD DEVIATION control at 10%. Turn the power ON. The needle of the edgewise meter should continue to rest directly over 0. If it does not, adjust the 25-turn screwdriver adjustable potentiometer (front panel) labeled DC ZERO until a zero reading is obtained. When rapid switching of all front panel controls (CPS FULL SCALE, MULTIPLIER, and % STANDARD DEVIATION) through all positions does not alter the zero reading, the dc level is correctly adjusted, i.e. the meter needle stays at zero for ANY combination of front panel control positions and does not move when a control is changed.

6.2 CALIBRATION PROCEDURE

A highly stable and accurate pulse source, such as the Tektronix 181 Time-Mark Generator, should be used in the calibration of the TC 590. Calibration adjustments are made with the single-turn potentiometer (R16) that is located toward the rear of the printed circuit board.

The procedure for calibration of the TC 590 is as follows:

1. Set the pulse source to a frequency of 1kHz (period of 1 msec).

2. Set the controls of the TC 590 as follows:

CPS FULL SCALE	10^3
MULTIPLIER	x1
% STANDARD DEVIATION	10%

3. Adjust the calibration potentiometer (R16) for a full scale reading (1kHz).

4. Set the MULTIPLIER on X2.5 and see that the reading is within 1.5 minor divisions (3%) of the true count rate. Readjust the calibration potentiometer (R16) if this reading is not obtained.

7.0 PARTS LIST

Components containing a P in the component number are mounted on the front or rear panel. The letter S indicates a component mounted on a switch.

RESISTORS

Unless otherwise specified, all resistors are ¼W. DC = 5% deposited carbon and MF = 1% metal film.

R1,R2	510Ω DC
R4	47, DC
R5	1.3k, DC
R6	2.7k, DC
RP7	2k, 25-turn WW Trimmer
R8	22, DC
R9	47, DC
R10	6.2k, DC
R11	47, DC
R12	1.3k, DC
R13	2k, DC
R14,R15	1k, DC
R16	470, Carbon Trimmer
R17	1k, DC
R18	100, MF
R19	909, MF
R20	4.02k, MF
R21	1.96M, ½WMF
R22	196k, MF
R23	19.6k, MF
R24	47, DC
R25,R26	11k, DC
R27	47, DC
R28,R29	4.7k, DC
RP30	2k, 25-turn WW Trimmer
R31	2.37k, MF
R32	1k, DC
R33	10k, MF
R34	196k, MF
RP35	2k, 25-turn WW Trimmer
R36	3.3k, DC
R37	2k, DC
R38	150, ½W CC
R39,R40	10, DC

CAPACITORS

GA = general application ceramic,
TA = tantalum, MYL = mylar, and M = dipped mica.

C1	15μF, TA
C2	50pF, GA

C3	100pF, GA
C4	150pF, M
C5	15μF, TA
C6	0.01μF, MYL
C7	0.1μF, MYL
C8	1.0μF, MYL
C9	100pF, GA
C10	0.01μF, GA
C11	1μF, TA
C12,C13	15μF, TA
C14,C15,C16	0.01μF, GA

SEMICONDUCTORS

D5	IN3714
D6	IN270
D7,D8,D9	IN4154
D10,D11,D12	IN4154
Q1,Q2	2N3250
Q3,Q4,Q5	2N4124
Q6	2N3958
Q7	2N4124
IC1	MC790P
IC2	MC1433CG

MISCELLANEOUS

L1,L2,L3	Ferrite Beads
M1	Edgewise Meter
SP1	DP4P Rotary Switch
SP2	SP3P Slide Switch
SP3	DP3P Rotary Switch
CN1	BNC (UG-1094/U)
CN2	Binding Post (Red)
CN3	Binding Post (Black)
CN4	NIM Module Connector

8.0 SERVICING

In the event of a component failure, replacement may be done in the field or the instrument may be returned to our plant for repair. There will be no charge for repairs that fall within the warranty.

9.0 SHIPPING DAMAGE

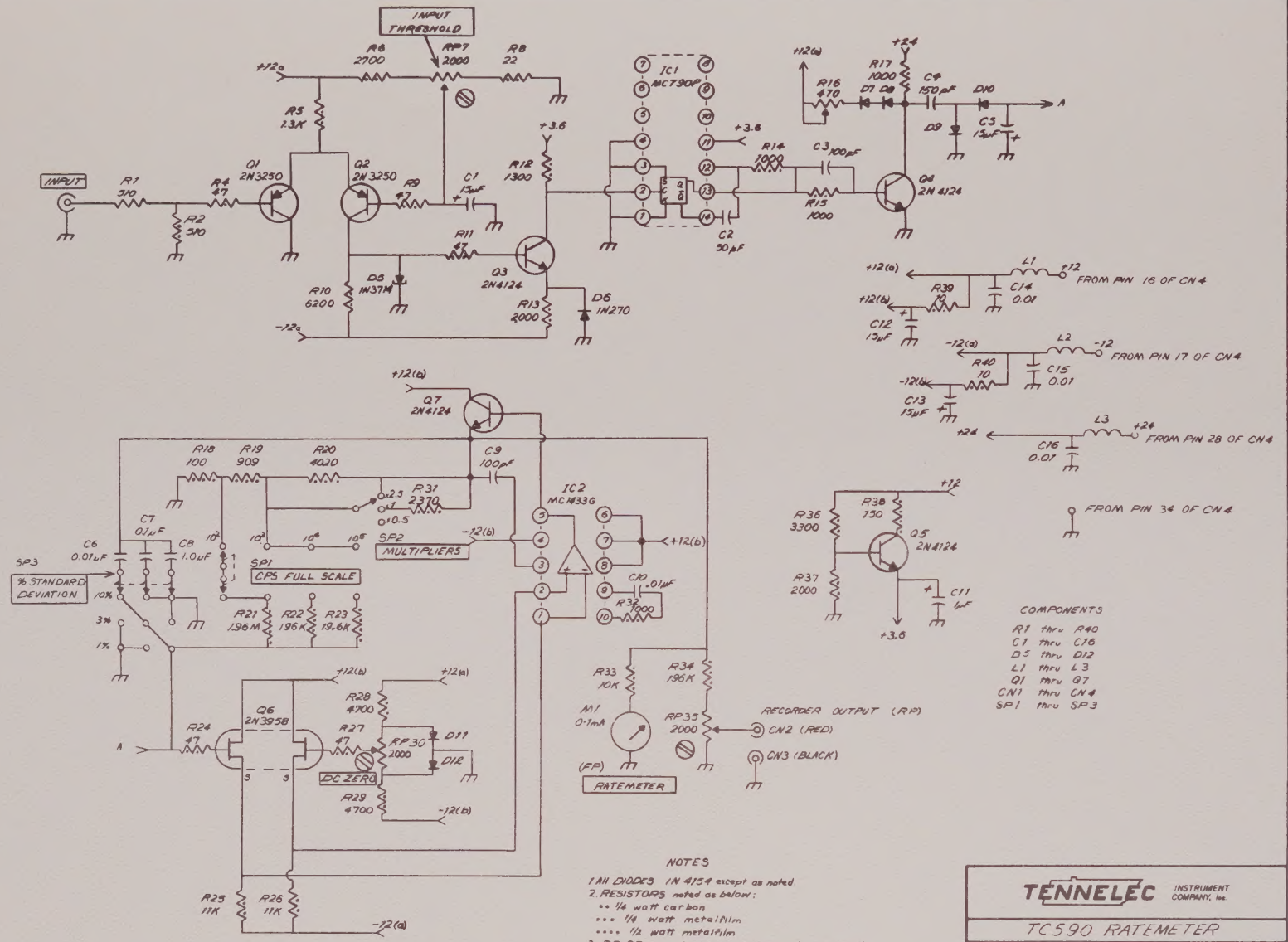
Upon receipt of the instrument, examine it for shipping damage. Damage claims should be filed with the carrier. The claims agent should receive a full report; a copy of the report that is sent to the claim agent should be sent to TENNELEC, Inc., P. O. Box D, Oak Ridge, Tennessee 37830. The model and serial number of the instrument must be included in the report. Any remedial action taken by TENNELEC, Inc. will be based on the information contained in this report.

10.0 WARRANTY

In connection with TENNELEC's warranty hereinafter setout, TENNELEC suggests that should a fault develop, that the customer immediately notify the TENNELEC Customer Service Manager. He may be able to prescribe repairs and to send replacement parts which will enable you to get the instrument operating sooner and at less expense than if you returned it.

Should return prove necessary, the TENNELEC Customer Service Manager must be informed either IN WRITING, BY CABLE, or BY TWX of the nature of the fault and the model number and serial number of the instrument. Pack the instrument well and ship PREPAID to TENNELEC, Inc., 601 Oak Ridge Turnpike, Oak Ridge, Tennessee 37830 via Air Express. As stated in the warranty, DAMAGE IN TRANSIT DUE TO INADEQUATE PACKAGING WILL BE REPAIRED AT THE SENDER'S EXPENSE as will damage that obviously resulted from abuse or misuse of the instrument.

Quotations for the repair of such damage will be sent for your approval before repair is undertaken.



NOTES

1. ALL DIODES 1N 4154 except as noted.
2. RESISTORS noted as below:
   - •• 1/4 watt carbon
   - ••• 1/4 watt metalfilm
   - •••• 1/2 watt metalfilm
3. RP, SP, etc. designate components mounted on panel.
4. D1 thru D4 are eliminated.
5. R3 eliminated.
6. ⊘ Designates TRIMPOT

NO	REVISION	DATE	BY
1	ICN NO. 69-44	10-28-69	JW

TENNELEC INSTRUMENT COMPANY, Inc.

TC590 RATEMETER

CIRCUIT DIAGRAM

DESIGNED	DATE	APPROVED
P.P.PLASTERER		E.F.
DRAWN	DATE	DWG. NO.
C.S.J.	5-23-69	TC590-1

MP MASTER
MA30995